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The U.S. Army Corps of Engineers (USACE) retained G.E.C., Inc. (GEC) and Black & Veatch Corporation (B&V) under Contract Number DACW27-03-D-005 to complete an evaluation study and preliminary design of combined sewer overflow (CSO) abatement facilities to supplement the City of Indianapolis' (City) Long Term Control Plan (LTCP). This report presents information on the Fall Creek/White River Tunnel, the Flow Augmentation System alternatives, and water reuse goals in consideration of the City's CSO LTCP. Information in this report is based on available existing data, and additional studies and investigations will be required prior to finalizing the conclusions presented in the report.

PROJECT BACKGROUND AND NEED

The City manages the wastewater collection system serving most of Marion County. Much of the older portions of the City, especially Center Township, are served by combined sewers that carry both storm water runoff and sewage. During rain events, combined sewers fill to their capacity and discharge a mixture of storm water runoff and sewage directly into waterways which adversely affects their water quality. The waterways include Fall Creek, White River, Pogues Run, Pleasant Run, Eagle Creek, and Bean Creek. In addition, fluctuating water levels and low dissolved oxygen (DO) in the waterways are challenges to achieving the benefits envisioned by the Central Indianapolis Waterfront Concept Master Plan. Subsequently, the City of Indianapolis and a team of consultants prepared a draft LTCP in April 2001 to address the concerns created by CSOs, and to meet state and federal regulations pertaining to CSOs. The overall goal of the LTCP is to identify alternatives to enhance water quality and to achieve compatibility with the Central Indianapolis Waterfront Concept Master Plan. Presently, the City is negotiating with regulatory agencies on the final LTCP.

A total of 43 CSO outfalls (27 along Fall Creek and 16 along White River), as shown in Figure ES.1, will be consolidated and conveyed to the proposed Fall Creek/White River Tunnel. One of the remedial measures to address this issue is to build consolidation sewers and convey the CSOs to a storage and conveyance tunnel.

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Figure ES.1

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CSO Outfall on Fall Creek

This would provide storage for CSO volumes during and after rainfall events. The draft LTCP included plans for two separate tunnels: the Fall Creek Deep Tunnel that would collect the CSOs along Fall Creek, and the White River Central Tunnel that would collect the CSOs along White River near and directly downstream of the Fall Creek confluence. However, revisions to the draft LTCP and negotiations between the City and regulatory agencies have resulted in combining the two separate tunnels into one tunnel. A Flow Augmentation System to provide supplemental flow in Fall Creek, Pogues Run and Pleasant Run during dry-weather periods is also proposed in the draft LTCP.

This report presents information on the Fall Creek/White River Tunnel System, and the Flow Augmentation System alternatives to supplement the City's CSO LTCP. Construction and project considerations, risk management strategies, and the decision screening methodology used to evaluate the alternatives also are included. The preliminary opinion of probable costs and project schedule also are provided. Many available documents and other sources of information were reviewed as part of the project. A detailed listing of the documents reviewed for this project is provided in Appendix A – Documents Reviewed.

The principal elements of this study include:

- Evaluate available regional geology and hydrogeology of the tunnel alignment corridor
- Conduct a Phase I Environmental Site Assessment program

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- Identify construction considerations
- Identify project considerations
- Identify alternatives for augmenting flow in Fall Creek, Pogues Run, and Pleasant Run
- Prepare a preliminary opinion of probable cost
- Develop a preliminary project schedule
- Develop a geotechnical exploration program
- Identify risk management strategies
- Utilize decision screening to assist in the recommendation of alternatives

Regional Geology and Hydrogeology

The available literature on the regional geology and hydrogeology of Marion County provided information for the preliminary development of the proposed tunnel corridor. In addition to known geological data, information on public wells and private wells has been included based on available literature and contact with Indianapolis Water and Mundell & Associates, Inc. as requested by the City of Indianapolis Department of Public Works (DPW). The Indiana Geological Survey (IGS) and the Center for Earth and Environmental Studies at the Indiana University – Purdue University Indianapolis (IUPUI) were contacted by the project team regarding additional geological data that may be available; however, no additional data was provided.

Fall Creek/White River Tunnel

The Fall Creek/White River Tunnel will consist of a main tunnel, primary working shaft, intermediate working shaft, tunnel boring machine (TBM) retrieval shaft, a Deep Tunnel Pump Station, consolidation sewers, drop shafts, and connection tunnels. Figure ES.2 presents an illustrative representation of the preliminary Fall Creek/White River tunnel system proposed for this project. The tunnel will be sized based on the required percent capture for CSO abatement along the Fall Creek and White River in the LTCP currently under negotiation with regulatory agencies. Main

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tunnel sizes that provide 95, 97 and 99 percent capture were evaluated. The percent capture volume is based on the annual average CSO flows in the system. The CSO volumes were provided by the Indianapolis Clean Stream Team (CST) and were based on CSO LTCP development efforts.

Figure ES.1 illustrates the proposed tunnel alignment alternatives, working shafts, retrieval shafts, intermediate working shafts, and associated components of the overall tunnel project. In addition, Figure ES.1 shows relevant Indianapolis landmarks related to the tunnel evaluation.

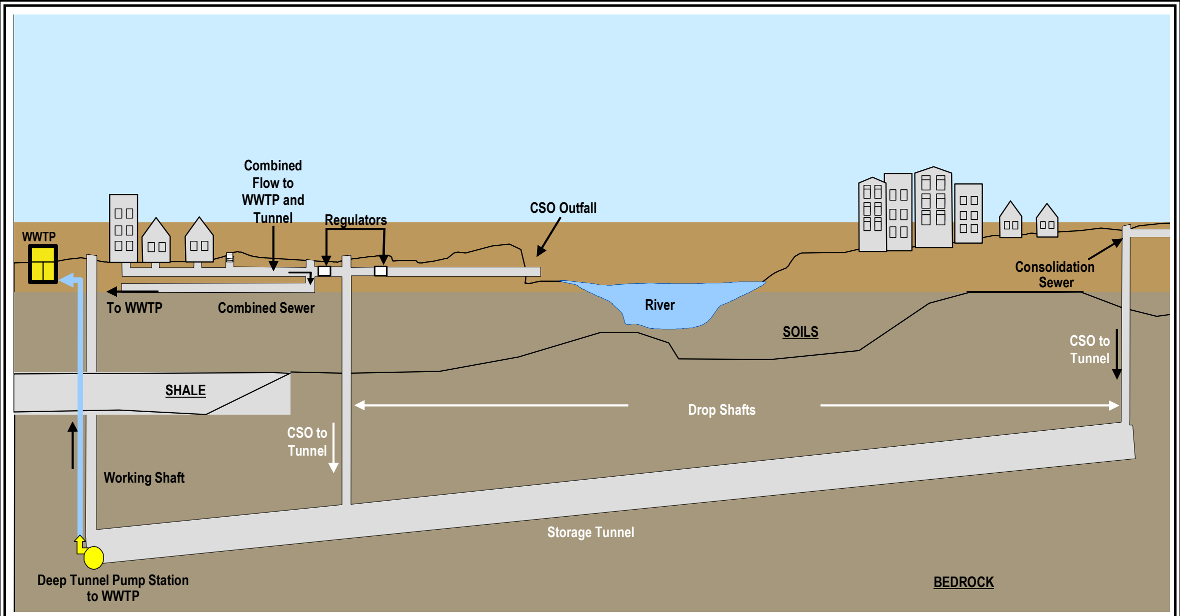

Figure ES.2 Fall Creek/White River Tunnel Illustrative Representation

The main tunnel alignment is bound by Keystone Dam on Fall Creek to the north and the future Interplant Connection Structure near CSO outfall 117 to the south as shown in Figure ES.1. The preliminary tunnel route generally follows Fall Creek and White River. Three alternative routes within the alignment corridor were identified for the main tunnel, including the West Alignment, Central Alignment, and East Alignment. Depending on the selected alignment, the tunnel length may vary from

7.5 to 10.5 miles. The tunnel diameter will vary based on the length. The West Alignment could have connection tunnels constructed only in rock, depending on the working and retrieval shafts selected. The Central and East Alignments have connection tunnels that are anticipated to be constructed in rock and soil.

As requested by DPW, the tunnel project should be designed to facilitate expansion of the main tunnel to accommodate 99 percent capture in the future. The rationale for considering future expansion of the tunnel system to accommodate 99 percent capture is based on future regulatory requirements and environmental goals, cost considerations, and the City's future financial capability to fund the tunnel expansion project. This requires the consolidation sewers, drop shafts and connection tunnels to be sized for 99 percent capture. The main tunnel will be sized for 95 or 97 percent capture with the ability to extend the tunnel to increase the system storage capacity to provide 99 percent capture in the future.

The primary working shaft is expected to be 40 to 50 feet in diameter, depending on the percent capture (95 or 97) for the main tunnel. The primary working shaft will be located at the southern end of the alignment near the future Interplant Connection Structure and CSO outfall 117. The primary working shaft will be used to launch the tunnel boring machine (TBM) and remove muck from the tunnel excavation. Three potential sites were identified for the working shaft site including the Reilly, Southern Avenue and Bluff Road shaft sites. The Bluff Road working shaft site is preferred because of its size, availability and close proximity to CSO outfall 117 and the future Interplant Connection Structure.

It is anticipated that a minimum of one drop shaft location, preferably midway along the alignment, will serve as an intermediate working shaft. This shaft will provide access to the tunnel, facilitate the delivery of supplies to the miners and provide access for the removal of muck. The intermediate working shaft also will minimize delays associated with long haul distances if only a primary working shaft is constructed. The size of the intermediate working shaft will vary depending on its function. If it is constructed as an access point midway along the alignment, the shaft is anticipated to be 20 to 25 feet in diameter.

It is anticipated that a 40-foot diameter retrieval shaft will be used to remove the TBM. Two retrieval shaft sites, Sutherland Avenue and Keystone Dam, along Fall Creek were identified at the northern extent of the tunnel alignment and evaluated. Both retrieval shafts could serve as a drop shaft location and eliminate the need for a drop shaft on the alignment.

Deep Tunnel Pump Station

The Deep Tunnel Pump Station will be a below-grade facility with an above-ground building. The facility will be designed to dewater the Fall Creek/White River Tunnel. The facility will be designed to initially dewater up to 97 percent capture volume, 310 million gallons (MG), within a 3-day period; with provisions to dewater 99 percent capture volume, 504 MG, in the future. The Deep Tunnel Pump Station will be located in a shaft at the downstream end of the tunnel near CSO outfall 117. Figure ES.3 presents an illustrative representation of the preliminary Fall Creek/White River Deep Tunnel Pump Station that is proposed for this project. The captured CSO will be conveyed to the proposed Interplant Connection Structure and diverted to either the Southport Advanced Wastewater Treatment (AWT) Plant through the Interplant Connection Sewer, or via siphons under the White River to the Belmont AWT Plant.

Consolidation Sewers, Drop Shafts, and Connection Tunnels

Forty-three CSO outfalls have been identified along Fall Creek and White River that require capture and diversion to the tunnel as shown in Figure ES.1. Consolidation sewers and diversion structures will be sized for 99 percent capture of the CSOs.

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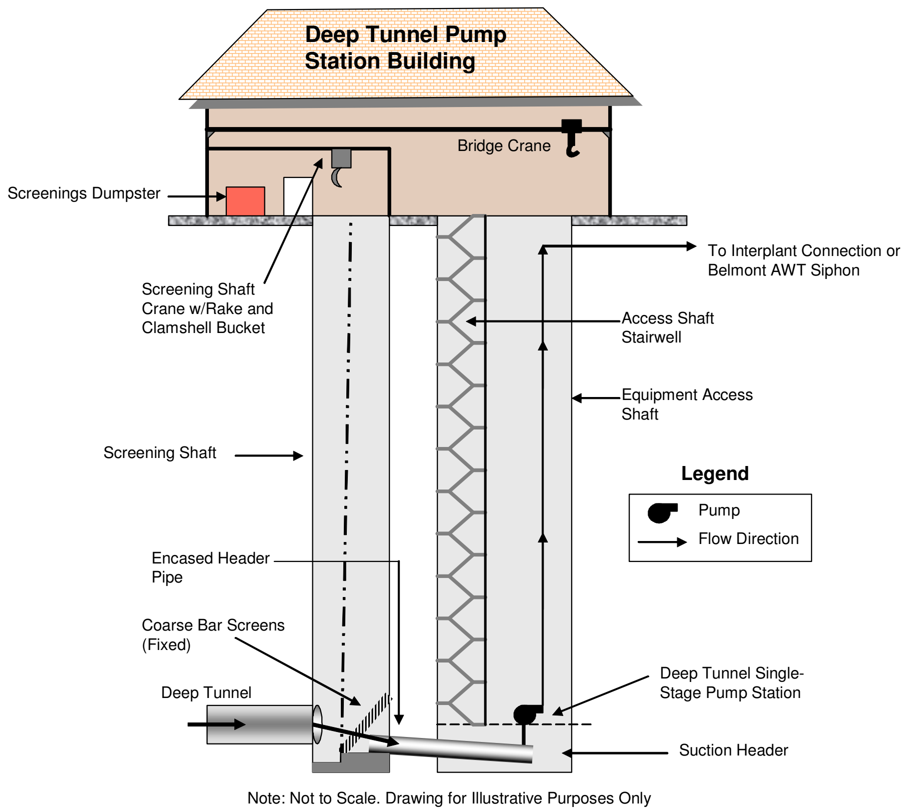

Figure ES.3 Deep Tunnel Pump Station Illustrative Representation

The CSO outfalls will be consolidated for cost considerations and operations efficiency prior to connecting them to the main tunnel. Various criteria were used to group the CSO outfalls.

Drop shafts are used to transfer CSOs from the consolidation sewers to the tunnel under controlled hydraulic conditions, controlled air entrainment and without damage to the overall system. Potential drop shaft sites were identified and evaluated based on proximity to the CSOs, availability of adequate construction space, and consideration of public and environmental impacts. A total of 21 drop shafts were identified along the tunnel alignment as shown in Figure ES.1. The drop shafts will be sized to convey 99 percent capture flows. This will allow for future expansion the tunnel system to achieve a 99 percent capture rate and could permit flexibility in the system operation to capture a greater level of CSOs in a particular area of the system if real-time controls are implemented.

Combined sewer overflows diverted to the consolidation sewers will be conveyed from the drop shafts to the main tunnel through connection tunnels. Connection tunnels will be sized to provide 99 percent capture of CSO.

CONSTRUCTION AND PROJECT CONSIDERATIONS

Construction considerations for the Fall Creek/White River Tunnel include safety concerns; main tunnel and connection tunnel construction techniques; shaft construction techniques; power availability; handling and disposal of tunnel and shaft spoils; handling, treatment and discharge of water present during tunnel and shaft construction; and protection of existing structures. These considerations are presented in the report.

By their very nature, infrastructure projects impact the community in which they are located. Construction of infrastructure projects involves the introduction of additional traffic, noise, vibrations, dust, and heavy machinery. Therefore, the impact of construction on the community and environment must be considered. Project considerations include the assessment of community outreach and coordination efforts, especially as related to odor, traffic, noise and lighting concerns.

Several project components, including access shafts, drop shafts, force mains, and outfall structures may be located in wetland areas. Prior to commencement of construction, a wetlands survey should be completed and the results verified by USACE.

The process of dropping CSOs from the near-surface collection system to the main tunnel will entrain air. To prevent a reduction in the tunnel's hydraulic capacity and transient releases of high pressure air from the drop shafts, a venting system should be installed. The vented air will likely require treatment to reduce odors. Activated carbon appears to be the best choice for odor control for this application. However, a detailed study is required during design to determine the liquid-phase and vapor-phase odor control potential of the existing CSOs near the proposed drop shaft locations.

A limited Phase I Environmental Site Assessment (ESA) was completed for the project corridor to identify areas that may pose a risk to locating the tunnel alignment, drop shafts, working shafts, or other necessary surface facilities in areas that may contain recognized hazardous, toxic, or radioactive waste (HTRW) conditions. The limited Phase I ESA revealed evidence of recognized environmental conditions (REC) within the project area, as presented in more detail in Appendix D. It is recommended that a Phase II ESA be conducted at all proposed shaft locations.

The Indiana Department of Environmental Management (IDEM) has been authorized by the U.S. Environmental Protection Agency (EPA) to implement most of the Federal Resource Conservation and Recovery (RCRA) Subtitle C hazardous waste management program in Indiana. All issues regarding the handling and disposal of contaminated soils and groundwater resulting from project operations should be coordinated with IDEM. IDEM guidelines for the handling of hazardous waste products state that recycling of waste is preferred to treatment and disposal.

Permanent subterranean easements are necessary along the entire main tunnel and connection tunnel alignments. The number and size of the easements will depend on the diameter of the main tunnel. The width of the tunnel easement is expected to be 50 to 70 feet depending on the required level of CSO control. A 50-foot wide underground easement has been assumed for a 26-foot finished diameter main tunnel. Each connection tunnel will require a subterranean easement with a maximum width of 40 feet. Property may need to be purchased, if not currently owned by the City. Land should be acquired for each shaft and consolidation sewer location. However, the purchasing and acquisition of property should be evaluated by the City on a site-specific basis during future project phases.

Permits need to be considered during the design for the construction of the Fall Creek/White River Tunnel and Flow Augmentation System projects because they impact the construction schedule and costs. Local, state, and federal regulations should be reviewed to ensure all permits are obtained in a timely fashion. A preliminary list of regulatory and private agencies and their required permits for this project are presented in the report.

RISK MANAGEMENT

Planning, design and construction of the Fall Creek/White River Tunnel and associated consolidation sewers, diversion and control structures are subject to a number of technical risks and contractual challenges that are inherent to large underground civil projects. Effective risk management and risk reduction, through continuous assessment, mitigation and contingency planning, are an essential and prudent management strategy. A systematic risk identification, evaluation, and management strategy will lead to early identification of risks and allow deployment of appropriate mitigation of possible onerous situations. A risk registry can be used to establish the basis for management of technical, contractual and socio-economic risks in the planning phase, subsequent preliminary engineering and design phases, and ultimately in the contract documents and construction management process. A preliminary risk registry is in the report.

Technical risks are project-specific and construction-related, including cost increases; property and economic damage; failures; potential loss of life; delays; not attaining design, operational, and quality standards; claims; disputes and differing site conditions. Contractual risks are related to the management of geotechnical reports, design approach, and construction. Socio-economic risks include impacts on the communities, businesses, and profit or non-profit interest groups.

GEOTECHNICAL EXPLORATION PROGRAM

Geotechnical site investigations should be conducted in multiple phases to obtain data for use during the planning and design of the tunnel system. Geotechnical investigations typically are performed in two or three phases during the preliminary and design stages. Geotechnical investigations provide the required data for finalizing the tunnel alignment, evaluating construction methods and developing a more accurate opinion of probable costs.

For the Phase 1 geotechnical exploration program, 26 borings are recommended to be drilled along the tunnel alignment. This boring program assumes that the West Alignment for the main tunnel, the Bluff Road working shaft and the Sutherland Avenue retrieval shaft are selected. Based on the data obtained from the Phase 1 geotechnical exploration program, Phase 2 should be developed and conducted during the detailed design to further define the existing conditions. Phase 3 geotechnical exploration programs are conducted during detailed design to fill any needed data gaps identified from the previous Phase 2.

FLOW AUGMENTATION SYSTEM

The Flow Augmentation System was evaluated based on needs identified in the draft CSO LTCP to augment low flow in Fall Creek, Pleasant Run and Pogues Run during dry-weather periods from May to October. The Flow Augmentation System includes the Belmont AWT Effluent Pump Station, Belmont Force Main, and Outfall Structures. Treated effluent from the Belmont AWT Plant will be pumped by the Belmont AWT Effluent Pump Station through the Belmont Force Main and discharge through outfall structures on Fall Creek, Pogues Run, and Pleasant Run. Figure

ES.4 presents an illustrative representation of the preliminary Flow Augmentation System that is proposed for this project.

The Belmont AWT Effluent Pump Station will provide approximately 20 million gallons per day (mgd) of reclaimed water to Fall Creek, 5 mgd to Pogues Run and another 5 mgd to Pleasant Run. The DPW requested an additional 30 mgd to the proposed flow to provide reclaimed water to potential commercial and industrial users. Therefore, the total capacity of the Belmont AWT Effluent Pump Station will be 60 mgd. The preliminary conceptual design is based on six 10 mgd pumping units. Two potential sites at the Belmont AWT Plant were identified and evaluated.

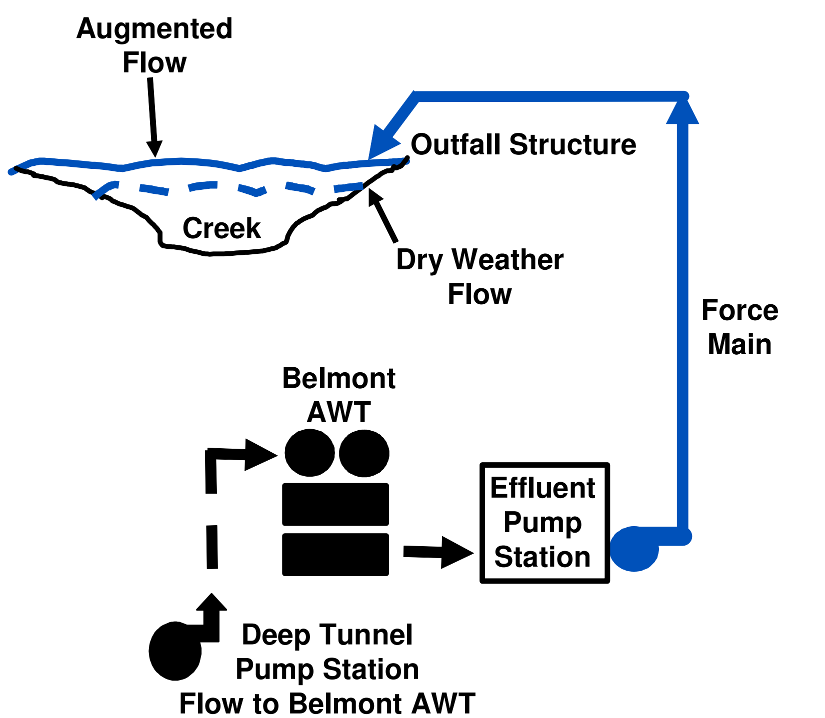

Figure ES.4 Flow Augmentation System Illustrative Representation

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Figure ES.5 presents an illustrative representation of the preliminary Belmont AWT Effluent Pump Station that is proposed for this project.

Four preliminary alternatives were evaluated for the Belmont Force Main route, including the Alternative 1 - Fall Creek/White River Alignment, Alternative 4 - Pleasant Run/Keystone Avenue Alignment, Alternative 5 - Pleasant Run/Main Tunnel Alignment, and Alternative 6 - Pogues Run/Main Tunnel Alignment. Alternative 1 requires two smaller diameter force mains to transport flow to discharge points at Pogues Run and Pleasant Run. Alternative 4 is the shortest route of the four alternatives under consideration. Alternative 5 passes through non-residential areas and requires two small branches constructed within greenways to provide flow to discharge points at Pogues Run and Pleasant Run. Alternative 6 passes through the downtown area.

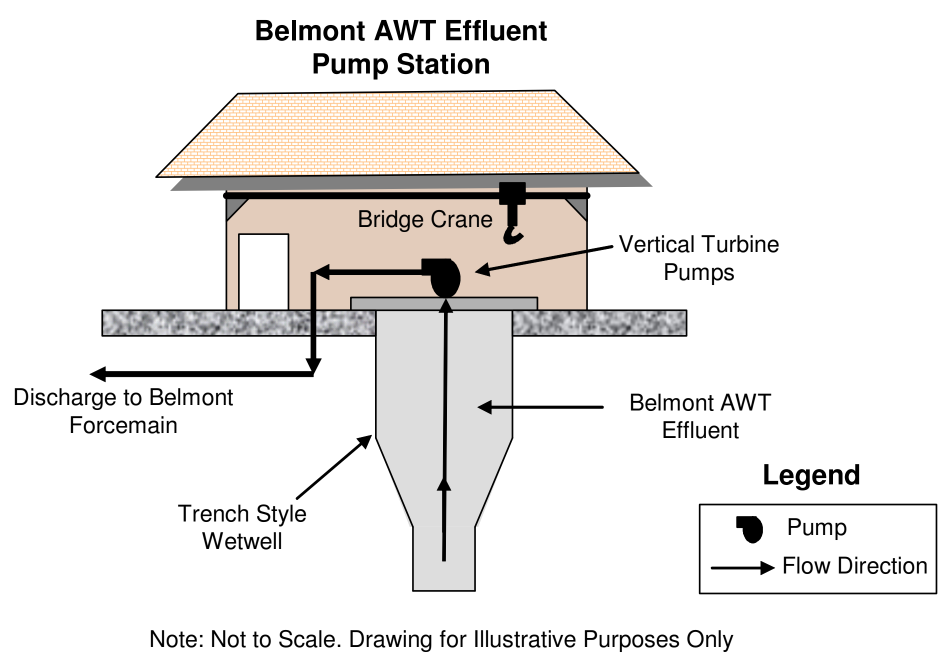

Figure ES.5 Belmont AWT Effluent Pump Station Illustrative Representation

Outfall alternatives, such as cascade aerators and constructed wetlands, were evaluated based on the flow augmentation goals for Fall Creek, Pogues Run, and Pleasant Run. The intent of the outfall structures is to increase dissolved oxygen (DO) levels in the Belmont AWT Plant effluent prior to discharge into Fall Creek, Pogues Run, and Pleasant Run. The outfall alternatives were evaluated based on their ability to increase DO, location of the structure, and the civil engineering and aesthetic aspects.

DECISION SCREENING

C*riterium Decision Plus* (CDP) software was used to assist in the evaluation of alternatives. CDP is a decision management tool that was used to organize, complete, and communicate complex decision-making tasks. Once criteria were developed, the program was used in a workshop setting to confirm the weightings with the aid of the stakeholders and apply them to the alternatives. Based on input from the stakeholders during the workshop, non-cost evaluation factors, subfactors and their weighting factors were determined and scores for the various alternatives were calculated. Following this process, preliminary costs for each of the alternatives were compared against the CDP weighed results in graphic form.

The tunnel alignment, working shaft, retrieval shaft, Belmont Force Main and outfall structure alternatives were weighted based on several criteria provided in tabular form. These criteria weights were modeled using CDP to develop decision scores based on non-cost factors. To determine which alternative is the most preferred, the capital cost and cost/benefit ratio for each alternative was compared to the CDP decision score. The following are the results:

- The West Tunnel Alignment alternative is rated as the most preferred considering it has the lowest capital cost and the lowest cost/benefit ratio as compared to the other alternatives. The non-cost decision score between the West and East Alignments indicates that the East would be slightly more favorable if costs were not a factor. Figure ES.6 presents the West Tunnel Alignment preferred alternative, and additional information is included in Chapter 3 of this report.

- The Bluff Road working shaft alternative is rated as the most preferred considering it has the highest non-cost decision score, the lowest capital cost, and the lowest cost/benefit ratio as compared to the other alternatives. Figure ES.6 presents the location of the Bluff Road working shaft preferred alternative, and additional information is included in Chapter 3 of this report.

- The Sutherland Avenue retrieval shaft alternative is rated as the most preferred considering it has a higher non-cost decision score, and a lower cost/benefit ratio as compared to the other alternative. While the Sutherland Avenue Shaft alternative does have a higher overall capital cost when factored in with the West Alignment costs, the non-cost factors such as impacts to well fields indicate that the lowest capital cost alternative (Keystone Dam) is not the most preferred. Figure ES.6 presents the location of the Sutherland Avenue retrieval shaft preferred alternative, and additional information is included in Chapter 3 of this report.

- Alternative 4B is rated as the most preferred alternative for the Belmont AWT Force Main conveying treated effluent to augment flows in Fall Creek, Pogues Run, and Pleasant Run. However, Alternative 5B has a similar cost/benefit ratio with the primary difference between Alternatives 4B and 5B being that Alternative 5B involves use of the Monon trail or adjacent railway for placement of the force main. Based on additional input from project stakeholders and the public, either alternative could be determined to be the most preferred. Figure ES.7 presents the force main alignment preferred alternative, and additional information is included in Chapter 12 of this report.

- Insert Figure ES.6

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Insert Figure ES.7

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- Several types of outfall structures were considered for augmenting flow in Fall Creek, Pogues Run, and Pleasant Run. The intent of the outfall structures is to increase dissolved oxygen (DO) levels of the treated effluent prior to discharge into the creek. Constructed wetlands were also evaluated with regards to possible treatment benefits and aesthetic value. Increases in the DO levels were estimated based on limited available data. It was determined that constructed wetlands need a large land area for effective treatment. Additional information on the outfall structures evaluated is included in Chapter 13 of this report.

- It was concluded that an outfall structure constructed of large rocks with a small wetland area for aesthetic value was most preferable at this stage in the flow augmentation project for Fall Creek. The DPW requested that the Indianapolis Parks Greenways submit a proposal for a preferred constructed wetland area near Keystone Dam. This constructed wetland proposal was provided to the project team and is included in Appendix L – Indianapolis Parks Greenways' Recommendation Proposal. The constructed wetland proposal was further expanded by the project team with additional details and an aerial drawing, as indicated in Chapter 13. Information on the preferred outfall structure and proposed constructed wetlands at the Fall Creek - Keystone Dam location is also included in Chapter 13 of this report.

- Several locations along Pogues Run were evaluated for the potential placement of an outfall structure to augment flows in the stream. It was concluded that an outfall structure constructed of large rocks discharging into the inlet of the constructed wetland and storm water detention pond near Emerson Avenue and Interstate 70 was most favorable at this stage in the project. Additional information on the preferred outfall structure location is included in Chapter 13 of this report.

- Several locations along Pleasant Run were evaluated for the potential placement of an outfall structure to augment flows in the stream. It was concluded that an outfall structure constructed of large rocks discharging near Shadeland Avenue and 21st Street was the most favorable alternative at this stage in the project. Additional information on the preferred outfall structure location is included in Chapter 13 of this report.

PRELIMINARY OPINION OF COST

The preliminary opinion of probable costs was developed for the Fall Creek/White River Tunnel project and the Flow Augmentation System, and are presented in Tables ES.1 and ES.2, respectively. All costs presented herein reflect price levels for January 2005 (ENR-CCI=7297), include preliminary land acquisition costs, and an allowance of 25 percent for contingencies. An additional allowance of 25 percent has been included for administration/program management, legal, engineering, construction administration, inspection services, surveying, and geotechnical investigations. The costs do not include contaminated soil and water mitigation or unusual construction conditions other than those specifically identified in this report.

PRELIMINARY PROJECT SCHEDULE

A preliminary project schedule was developed for the Fall Creek/White River Tunnel and the Flow Augmentation System. Both projects may be completed concurrently, but are independent of each other during future construction. The total project duration for the Fall Creek/White River Tunnel from the beginning of the Phase 1 geotechnical exploration program through the completion of construction and tunnel start-up is estimated to be approximately 16 years. The project duration for the Fall Creek/White River Tunnel can be reduced by approximately three years, for a total duration of 13 years, if the main tunnel was constructed in two segments concurrently using two Contractors.

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Table ES.1
Opinion of Probable Costs[1] Summary – Fall Creek/White River Tunnel Alternatives

Item	95 Percent Capture	97 Percent Capture
West Alignment Alternative		
Total Probable Construction Cost [2, 3, 4]	**$539,500,000**	**$666,500,000**
Engineering, Legal, and Administration (25%)	$134,900,000	$166,700,000
Total Probable Project Cost	**$674,400,000**	**$833,200,000**
Central Alignment Alternative		
Total Probable Construction Cost [2, 3, 4]	**$567,200,000**	**$693,500,000**
Engineering, Legal, and Administration (25%)	$141,800,000	$173,400,000
Total Probable Project Cost	**$709,000,000**	**$866,900,000**
East Alignment Alternative		
Total Probable Construction Cost [2, 3, 4]	**$585,300,000**	**$711,200,000**
Engineering, Legal, and Administration (25%)	$146,400,000	$177,800,000
Total Probable Project Cost	**$731,600,000**	**$889,000,000**

[1] All costs presented reflect price levels of January 2005 (ENR-CCI = 7297).
[2] Total Probable Construction Cost includes an allowance of 25% for contingencies.
[3] Connection tunnels, consolidation sewers and drop shafts sized for 99 percent capture.
[4] Based on Bluff Road working shaft site and Sutherland Avenue retrieval shaft site.

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Table ES.2
Opinion of Probable Costs[1] Summary – Flow Augmentation System

Item	Cost
Belmont AWT Effluent Pump Station	
Total Probable Construction Cost	$12,000,000
Engineering, Legal, and Administration (25%)	$3,000,000
Total Probable Project Cost[5, 6]	**$15,000,000**
Belmont Force Main[2]	
Total Probable Construction Cost	$38,600,000
Engineering, Legal, and Administration (25%)	$9,600,000
Total Probable Project Cost[5, 6]	**$48,200,000**
Fall Creek Outfall Structure[3]	
Total Probable Construction Cost[6]	$300,000
Engineering, Legal, and Administration[5] (25%)	$100,000
Total Probable Project Cost[5, 6]	**$400,000**
Pogues Run and Pleasant Run Outfall Structures[4]	
Total Probable Construction Cost[6]	$160,000
Engineering, Legal, and Administration[5] (25%)	$40,000
Total Probable Project Cost[5]	**$200,000**
Total Probable Project Cost for Flow Augmentation[5, 6]	**$63,800,000**

1 All costs presented reflect price levels of January 2005 (ENR-CCI = 7297)

2 Alternative 4B was selected per CDP analysis for the force main

3 Large Rocks with Small Constructed Wetland option was selected per CDP analysis for the outfall

4 Large Rocks structure was selected per CDP analysis for the outfall, and price reflects two structures, one each for Pogues Run and Pleasant Run

5 Includes contingencies (25%)

6 Rounded up to the nearest hundred-thousand

To address funding limitations or project goals, the main tunnel could be constructed in two segments (White River and Fall Creek) with the segments constructed consecutively. Using this approach, the White River segment (from Bluff Road working shaft to near the White River/Fall Creek confluence) could be placed into operation while the Fall Creek segment (from near the White River/Fall Creek confluence to the Sutherland Avenue retrieval shaft) is under construction or constructed at a future date. To accomplish this, the Deep Tunnel Pump Station would need to be constructed at the conclusion of construction of the White River tunnel segment. This would allow the White River tunnel segment to be placed into operation before the Fall Creek segment is complete.

The total duration from beginning of design through completion of the Flow Augmentation System construction and start-up is estimated to be approximately seven and a half years. The project duration for the Flow Augmentation System can be reduced by a year, for a total duration of six and a half years, if the Belmont Force Main is constructed in two segments concurrently. These preliminary project schedules are based on a number of assumptions that need to be verified during the design phase. Table ES.3 summarizes the preliminary project duration for the Fall Creek/White River Tunnel and Flow Augmentation System.

When constructing a major project such as the Fall Creek/White River Tunnel and Flow Augmentation System, it is paramount to consider the various project delivery alternatives, as this will have a significant impact on the project duration and cost. The traditional design-bid-build project delivery approach was assumed for the preparation of this evaluation report, preliminary project schedule and preliminary opinion of probable costs. However, the project delivery approach should be determined prior to commencement of detailed design.

Table ES.3
Preliminary Project Duration Summary

Project Phase	Duration, months	
	Fall Creek/White River Tunnel	Flow Augmentation System
Design Phase	65	37
Bid Phase	20	20
Construction Phase and Start-up	107	35
Total	192	92

CONCLUSIONS AND RECOMMENDATIONS

Detailed conclusions and recommendations for the evaluation study are included in Section 17 – Conclusions and Recommendations of the report. Based on information presented in this report, several conclusions were drawn for important components of the project. These conclusions are as follows:

- Fall Creek/White River Tunnel System – Based on the conclusions developed during this evaluation, the West Alignment for the main tunnel, Bluff Road working shaft, and Sutherland Avenue retrieval shaft are the preferred alternatives. The main tunnel is anticipated to be initially sized for 95 percent capture of CSOs unless dictated otherwise in the final Long Term Control Plan. The tunnel system includes an intermediate working shaft at drop shaft DS-08 location, 21 drop shafts, and a Deep Tunnel Pump Station. Preliminary probable project and present worth costs for the recommended tunnel system alternative are presented in Table ES.4.

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Table ES.4
Opinion of Probable Costs[1] Summary

Item	Cost
Tunnel System – West Alignment	
Total Probable Construction Cost	$539,400,000
Total Probable Project Cost	$674,400,000
Total Estimated Present Worth Cost w/ O&M and Residual Costs	$655,100,000
Flow Augmentation System	
Total Probable Construction Cost	$51,100,000
Total Probable Project Cost	$63,800,000
Total Estimated Present Worth Cost w/ O&M and Residual Costs	$55,800,000

[1] All costs presented reflect price levels of January 2005 (ENR-CCI = 7297).

- Flow Augmentation System – Based on the conclusions developed during this evaluation, it is probable that Alternative 4B will be the selected force main route, the large rocks with small constructed wetland alternative will be constructed at the Fall Creek discharge point near Keystone Dam, and a large rocks cascade aeration outfall structure will be constructed at both Pogues Run and Pleasant Run . The recommended Flow Augmentation System also includes a 30 mgd pump station at the Belmont AWT Plant with provisions to expand the pump station capacity to 60 mgd in the future to meet water reuse goals. Preliminary probable project and present worth costs for the recommended Flow Augmentation System are presented in Table ES.4.

- It is recommended that the Phase 1 geotechnical exploration program be conducted during the current planning phase of the project. Completion of the Phase 1 geotechnical exploration program in the planning phase will also assist in refining the tunnel alignment; confirming appropriate construction methodologies; identifying the risks that may require mitigation prior to the design; and revising the preliminary opinion of probable construction costs.

- It is recommended that the preliminary sizing of the main tunnel, consolidation sewers, drop shafts, connection tunnels and Deep Tunnel Pump Station be revisited and adjusted, as appropriate, following the completion of the Fall Creek and White River CSO hydraulic modeling.

- A land acquisition study should be completed early in the design phase of the project based on the outcome of the Phase 1 geotechnical exploration program and the sampling and analyses of soils and groundwater.

- A power availability assessment should be completed for the proposed primary working shaft and Deep Tunnel Pump Station sites.

- Based on the outcome of the final CSO LTCP, it is recommended that the DPW make a determination of design flexibility for future expansion of the main tunnel. If desired, it is recommended that consideration of land acquisition at future expansion points be included in the early design phase of the project.

- A risk management assessment and bonding capacity evaluation for construction of the Fall Creek/White River Tunnel project should be evaluated at early stages in the design. These evaluations will provide the City with adequate information to minimize project risks before construction begins and ensure the recommended project and construction phasing can be financially bonded.

- Flow augmentation and water reuse goals for the project should be evaluated carefully prior to the design.

EXECUTIVE SUMMARY

- A Phase II Environmental Site Assessment (ESA) is recommended for the shaft sites, connection tunnels, consolidation sewer routes and tunnel alignments.

- A Phase I ESA is recommended for the force main routes, and outfall structure locations for Fall Creek, Pogues Run, and Pleasant Run. This program would identify potential contamination for risk mitigation purposes prior to design and construction, and indicate if a Phase II ESA is recommended.

- Periodic updates to the opinion of probable costs should be conducted at major milestones and as additional information and data are obtained throughout the planning and design of the Fall Creek/White River Tunnel and Flow Augmentation System projects.